European perspectives on regional estimates of standing water bodies and the relevance of man-made ponds

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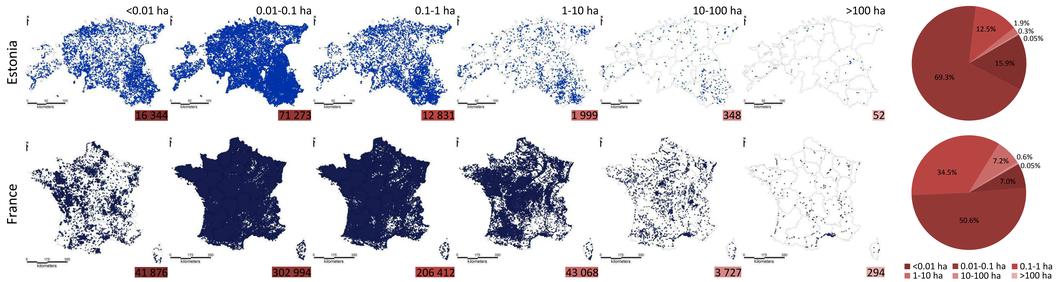
Introduction

- The majority of terrestrial standing water bodies (SWB) are small in size, however, their abundance and distribution is not fully known and they are under-represented in legislation. For example, the EU Water Framework Directive 2000/60/EC proposes a threshold surface area for reporting as 50 ha.
- Small SWB can be well represented in the state-level inventories and studies, e.g. <10 ha in Meybeck, 1995, <1 ha in Rjanžin 2005, or <0.05 ha in Kuusisto & Raatikainen 1988, but these studies are region-specific and not suitable for estimating global inventories. Also, there is a bias towards studies of natural lakes while abundance of man-made water bodies is understudied.
- The models for global inventories of SWB are so far not sufficiently designed for estimating the relative abundance of small SWB (below 0.2 ha) and provide differing estimates (Downing et al. 2006; Verpoorter et al. 2014).
- In this pilot study, we :
  (1) suggest a bottom-up approach for estimating the number of SWB at EU-level that combines the ground-validated data on water bodies from state inventories and data from peer-generated map databases (Bartout & Touchart, 2013).
  (2) assess the inventories and relative importance of small terrestrial water bodies of two different countries, Estonia and France.

Abundance and size distribution

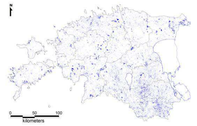


The distribution of the SWB in Estonia and France. Maps are showing SWB abundance in different size ranges. Every dot on the map represents single SWB. The number in corners indicates total counts. Pie-plots are summarising the findings.

Conclusions

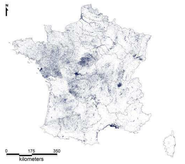
- In Estonia the density of the waterbodies is 2.3 per km2 and in France 1.1 per km2. The median size of standing water bodies (SWB) in Estonia and France is smaller (0.026 ha and 0.071 ha, respectively) than the detection limit (0.2 ha) of the most recent global inventory based on GLOWABO data from satellite imagery (Verpoorter & al., 2014). Our analysis of the abundance and distribution EU water bodies suggests that these global counts underrepresent the hydrologically complex terrain of European territory.
- Our present estimates of all EU inventory of water bodies in all size ranges based on OSM database is ~1 million. The comparison of ground-validated data from national inventories and OSM database shows that reliability of OSM data varies between countries. The number of small standing water bodies remains underestimated, especially in size class below 0.1 ha (the average representation of SWB for EU level in size range 0.01 - 0.1 ha is 18%, below 0.01 ha is inaccurate).
- The calculated perimeter in Estonian and French SWB is consistent with a hypothesis by Verpoorter et al. (2014) that the most of the global land-lake interface is in small SWB.
- The abundance and size distribution of SWB in Estonia and France shows the relative importance of very small and man-made water bodies in EU context. The abundance of man-made SWB is globally less studied, especially in the smallest size ranges, but they have important role in sustaining aquatic life while at the same time supporting human activities. Because of their small size and catchments, small SWB are far easier and cheaper to protect and restore than larger SWB.
- All SWB, including small and man-made ponds, play an important role in ecosystem services and require careful management to avoid hydrological and environmental deterioration.
- Combining the national inventories of SWB proves to be the best available solution for estimating the regional inventories of SWB. For each geographical region specific function must be used in order to calculate the total number of SWB.

Geographical and historical settings



Estonia (45 215 km^2) belongs to the Boreal region of Europe.
The surface topography is flat (60% of the territory is < 50 m a.s.l).

The majority of lake basins formed during the ice retreat after the Last Glacial Maximum.
Besides forests (50%), wetlands are the most common landscape feature covering 20% of the territory. Peat-rich mires with characteristic bog pools are abundant. Creation of man-made lakes and ponds has been relatively common throughout the centuries. The man-made water bodies serve range of ecological, cultural and agricultural purposes.

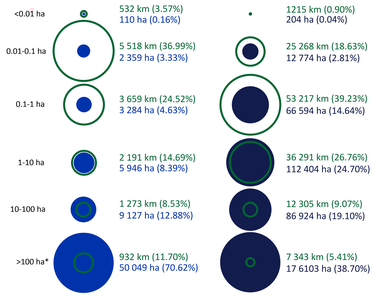


EU territory of France (547 030 km^2) possesses a wide variety of coastal, lowland and mountain landscapes.

Except few mountain margins, France was not glaciated during the Würm period.
Forests account for 28% of land area. The territory has extensive river systems (Seine, Loire, Garonne and Rhone).
Most of the water bodies are artificial (~98%), smaller than Nordic lakes and built on fluvial continuum. The tradition of creating the fishponds was developed in Middle Ages and today they provide variety of agricultural functions. Historically, France has also a tradition of forming artificial wetlands.

Shoreline lenght VS area

The comparison of size classes of SWB in Estonian Topographic Database (ETD) and French national inventory. The green color indicates the calculated total shoreline lenght (perimeter) and blue color indicates the total area.



* excluding L. Peipsi (area 354 105 ha; perimeter 814 km)

Natural VS man-made

In France, majority (98-99%) of SWB are man-made.
In Estonia, 56% of total inventory of SWB are man-made and 44% natural SWB.

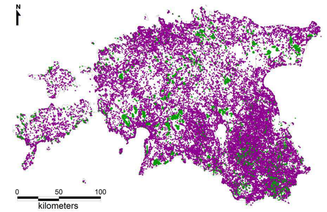


Table shows the total inventory of SWB in Estonia divided in size ranges.

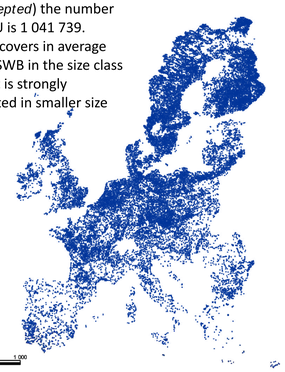
	Perimeter, km		Area, ha		Count	
	Nat.	Man.	Nat.	Man.	Nat.	Man.
<0.01 ha	291	241	60	51	8 712	7 632
0.01-0.1 ha	2 443	3 076	973	1 386	31 791	39 482
0.1-1 ha	1 053	2 607	866	2 421	3 450	9 383
1-10 ha	976	1 213	3 085	2 857	963	1 036
10-100 ha	766	500	6 268	2 759	223	125
>100 ha*	626	305	38 032	12 011	45	7
Sum	6 156	7 942	49 284	21 490	45 184	57 663
Min.	0.02	0.01	0.00	0.00	-	-
Max.	130	211	26 901	10 553	-	-
Median	0.06	0.07	0.02	0.03	-	-
Mean	0.14	0.14	1.09	0.37	-	-

* Excluding L. Peipsi

Only ~ 1500 of natural water bodies are lakes (mean surface area – 30 ha excluding L. Peipsi), remaining SWB are small bog pools (mean surface area – 0.03 ha).

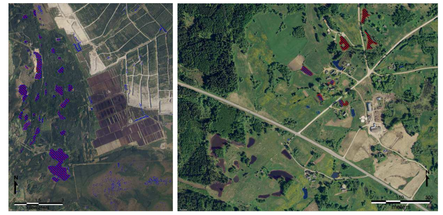
SWB at EU scale

According to the analysis of the OpenStreetmap (OSM) database (Partout, *accepted*) the number os SWB in EU is 1 041 739.
This number covers in average over 80% of SWB in the size class >10 ha, but it is strongly underestimated in smaller size



OpenStreetMap (OSM) is a map database built by a community of mappers that contribute and maintain data.

Quality of data



Repeated random check of OSM and Estonian national inventory datasets against aerial imagery reveals that both dataset have some limitations. In both cases, some SWB remain unrepresented (majority of bog pools is missing from OSM).

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Acknowledgments

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